August 12, 2004

Mr. Jim Smith
Hartman Engineering, Inc.
527 West Esplanade Avenue, Suite 300
Kenner, Louisiana 70065

Re: Geotechnical Engineering Services
Proposed Earthen Terraces
Freshwater Introduction
South of Highway 82, ME-16
Vermillion Parish, Louisiana
PSI File Number 254-35162-1

Dear Mr. Smith:

Professional Service Industries, Inc. is pleased to transmit our Geotechnical Engineering Services Report for the referenced project. This report includes the results of field and laboratory testing, and recommendations for design of the proposed Earthen Terraces.

We appreciate the opportunity to perform this Geotechnical Study and look forward to continued participation during the design and construction phases of this project. If you have any questions pertaining to this report, or if we may be of further service, please contact our office.

Respectfully submitted,
PROFESSIONAL SERVICE INDUSTRIES, INC.

Mohammad Tavassoli, Ph.D., P.E.
Regional Engineer

Malay Ghose Hajra, Ph.D., P.E.
Project Engineer

MT:MGH:gsm

GEOTECHNICAL ENGINEERING REPORT

PROPOSED EARTHEN TERRACES
FRESHWATER INTRODUCTION
SOUTH OF HIGHWAY 82, ME-16
VERMILLION PARISH, LOUISIANA

PSI FILE NUMBER 254-35162-1

PREPARED FOR

MR. JIM SMITH
HARTMAN ENGINEERING, INC.
527 WEST ESPLANADE AVENUE
SUITE 300
KENNER, LOUISIANA 70065

AUGUST 12, 2004

BY

PROFESSIONAL SERVICE INDUSTRIES, INC.
724 CENTRAL AVENUE
JEFFERSON, LOUISIANA 70121

TABLE OF CONTENTS

Page No.

EXECUTIVE SUMMARY 1

PROJECT INFORMATION 1
- Project Authorization 1
- Project Description 1
- Purpose and Scope of Services 2

SUBSURFACE CONDITIONS 3
- Field Exploration 3
- Drilling and Sampling Procedures 3
- Laboratory Testing Program 4
- Subsurface Condition 4
- Groundwater Information 4

RECOMMENDATIONS 5
- General 5
- Soil Bearing Capacity 5
- Estimated Settlements 5
- Slope Stability Analyses 6
- Staged Construction 7

REPORT LIMITATIONS 7

APPENDIX I RECORDS OF SUBSURFACE EXPLORATION
KEY TO TERMS AND SYMBOLS USED ON LOGS

APPENDIX II SLOPE STABILITY FIGURES

EXECUTIVE SUMMARY

An exploration and evaluation of the subsurface conditions has been completed to determine the feasibility of the proposed earthen terraces for freshwater introduction, south of Highway 82, Project ME-16, in Vermillion Parish, Louisiana. A total of four (4) soil test borings (B-1 thru B-4) have been drilled to a depth of 25 feet below mudline and selected soil samples tested in the laboratory. The subsoils encountered in the borings generally consisted of very soft gray clays to depths of about 12 feet. This is underlain by stiff clays to a depth of at least 25 feet, the maximum depth explored.

It is understood that consideration is being given to earthen terraces having heights ranging from 4 to 6 feet. Furnished information indicates that it is desired to use the on-site material by bucket dredging in order to build the proposed earthen terraces. The purpose of these terraces will be to slow the wave action in the bayou and to allow for marsh grass to grow in this area. In view of this, analyses were performed with regard to slope stability, bearing capacity and settlements for the proposed earthen terraces and the results are given in the subsequent sections.

The owner/designer should not rely solely on this Executive Summary and must read and evaluate the entire contents of this report prior to utilizing our engineering recommendations in preparation of design/construction documents.

PROJECT INFORMATION

Project Authorization

Professional Service Industries, Inc. (PSI) has completed a geotechnical exploration for the proposed earthen terraces in Vermillion Parish, Louisiana. Our services were authorized by Mr. Jim Smith of Hartman Engineering, Inc., Consulting Engineers for the project. This exploration was accomplished in general accordance with PSI Proposal Nos. 254-35021-2 dated November 19, 2003.

Project Description

It is understood that the proposed construction will consist of 26,000 linear feet of earthen terraces. The terraces will have a crown width of 10 feet and a toe elevation of –1.0. Consideration is being given to terraces with heights ranging from 4 to 6 feet. However, the height and side slopes of terraces will be determined based on the results of slope stability, bearing capacity and settlement analyses. The earthen terraces are intended to dissipate the wave energy developed in the open water areas within the project area. Once constructed, the terraces will be planted in an effort to establish vegetation.

The soil parameters obtained from the field and laboratory testing results were used to

calculate the structural integrity of the proposed earthen terraces. Analyses were performed by evaluating the bearing capacity, global slope stability, and consolidation settlement for the proposed earthen terraces. Global slope stability analyses were performed to determine the adequate terrace side slope, and minimum offset distance (berm width) between the borrow area and terrace toe. Furnished information indicates that construction of terraces will consist of bucket dredging the in-situ soils near the proposed terraces and use this on-site material to build the terraces. It is further understood that the low water could reach EL.+0.8 in the area of the proposed terraces.

The geotechnical recommendations presented in this report are based on the available project information, proposed terraces cross section and locations and the subsurface materials described in this report. If any of the noted information is incorrect, please inform PSI in writing so that we may amend the recommendations presented in this report if appropriate and if desired by the client. PSI will not be responsible for the implementation of its recommendations when it is not notified of changes in the project.

Purpose and Scope of Services

The purpose of this study was to explore the subsurface conditions at the site to enable an evaluation of bearing capacity, settlement and slope stability for the proposed earthen terraces. Our scope of services included drilling four (4) soil borings (B-1 thru B-4) to a depth of 25 feet below mudline, select laboratory testing and preparation of this geotechnical report. This report briefly outlines the testing procedures, presents available project information, describes the site and subsurface conditions and presents preliminary recommendations regarding the following:

- Bearing capacity, slope stability and estimates of settlements for the proposed earthen terraces;
- Constructability and use of on-site material for construction of the proposed earthen terraces;

The scope of services did not include an environmental assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, surface water, groundwater, or air on or below, or around this site. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes. Prior to development of this site, an environmental assessment is advisable.

SUBSURFACE CONDITIONS

Field Exploration

The field exploration, which was performed to evaluate the engineering characteristics of the foundation materials, included a reconnaissance of the project site, drilling test borings and recovering undisturbed and representative disturbed soil samples. Water level measurements of any groundwater encountered in the test borings were also observed and recorded.

As discussed above, soil borings (B-1 thru B-4) were drilled to depths of 25 feet. The boring depths are in reference to the existing ground surface at the time of the field exploration. The number and depth of the borings were determined by LDNR. The latitude and longitude of the boring locations are given below.

Boring Number	Latitude	Longitude
B-1	29° 39' 41"	92° 37' 04"
B-2	29° 39' 12"	92° 36' 58"
B-3	29° 39' 30"	92° 36' 12"
B-4	29° 39' 05"	92° 36' 36"

Drilling and Sampling Procedures

All borings were drilled with an airboat mounted drilling rig equipped with a rotary head. Wet rotary techniques were used to advance the boreholes. Samples were generally obtained contiguously from the ground surface to a depth of ten feet and at maximum five foot intervals thereafter.

Undisturbed samples of cohesive soils were generally obtained using thin-wall tube sampling procedures in general accordance with the procedures for "Thin-Walled Tube Geotechnical Sampling of Soils" (ASTM D 1587). These samples were extruded in the field with a hydraulic ram. Undisturbed and disturbed samples were identified according to boring number and depth, were placed in polyethylene plastic wrapping to protect against moisture loss, and were transported to the laboratory in special containers to prevent disturbance.

All of the samples obtained from the field exploration were identified and evaluated by experienced geotechnical personnel upon arrival at the laboratory.

Laboratory Testing Program

In addition to the field exploration, a supplemental laboratory testing program was conducted to evaluate additional pertinent engineering characteristics of the foundation materials

necessary in analyzing the behavior of the proposed earthen terraces with regard to bearing capacity, slope stability and settlement.

The laboratory testing program included supplementary visual classification and water content tests on the soil samples. In addition, selected samples were subjected to unconfined compression testing, Atterberg Limits, percent passing a 200 sieve, consolidation tests, and organic content tests. Additional estimates of shear strength were also determined through the use of a hand torvane.

The laboratory testing program was conducted in general accordance with applicable ASTM Specifications. The results of these tests can be found on the accompanying boring logs located in Appendix II. The consolidation test results are also given in Appendix I.

Subsurface Condition

Reference to the logs of borings shows that beginning at the ground surface there is very soft gray clays to a depth of about 12 feet. This is underlain by stiff greenish gray and reddish tan clays to a depth of at least 25 feet, the maximum depth explored.

The above subsurface description is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The boring logs included in the appendix should be reviewed for specific information at the boring locations. These records include soil descriptions, stratifications, penetration resistances, locations of the samples and laboratory test data. The stratifications shown on the boring logs represent the conditions only at the actual boring locations. Variation may occur and should be expected between the boring locations. The stratifications represent the approximate boundary between subsurface materials and the actual transition may be gradual. Water level information obtained during field operations is also shown on the boring logs. The samples, which were not altered by laboratory testing will be retained for 60 days from the date of this report and then will be discarded.

Groundwater Information

The water depth to the mudline at the boring locations at the time of drilling ranged from 2 to 4 feet. The water depth can fluctuate due to precipitation, tidal fluctuation, etc.

RECOMMENDATIONS

General

It is understood that the proposed construction will consist of approximately 26,000 linear

feet of earthen terraces. Furnished information indicates that the crown of the earthen terraces will be 10 feet in width and the bottom or toe of the terraces will be at EL.-1.0 NGVD. Consideration is being given to raise the crown of the terraces to elevations ranging from +4.0 to +6.0 depending on the results of slope stability, bearing capacity and settlement analyses. It is further understood that the area near the proposed terraces will be dredged and the in-situ material will be used to build the terraces. Analyses were performed based on the above design parameters and the subsurface data from our borings for bearing capacity, slope stability and settlement of the proposed terraces and the results are given in the subsequent sections.

Soil Bearing Capacity

The soil bearing value varies depending on the type of soil which is present at or below the bottom of the proposed terraces. The near surface soils generally consist of very soft clays at the subject site and is believed to have sufficient bearing capacity to support the proposed terraces; however, staged construction for the terraces is recommended to allow for some consolidation of the subsoils to occur in order to increase the bearing capacity and induce some settlement prior to final stage of construction. In addition, it is recommended that a geotextile fabric such as Mirafi Geolon (HS400 or HS600) or equivalent be placed at the mudline prior to construction of the terraces to further improve the stability and bearing capacity.

Estimated Settlements

Analyses were performed based on the borings and laboratory test data to estimate settlement of the proposed terraces having heights ranging from 4 to 6 feet and the results are given below:

Terrace Crown Elevation (Feet)	Terrace Toe Elevation (Feet)	Estimated Settlement			
		30% Consolidation	50% Consolidation	80% Consolidation	100% Consolidation
+5	-1.0	4.5" (1.5 yrs.)	7" (4 yrs.)	11" (12 yrs.)	14" (>12 yrs.)
+4	-1.0	4" (1.5 yrs.)	6" (4 yrs.)	10" (12 yrs.)	12" (>12 yrs.)
+3.0	-1.0	3" (1.5 yrs.)	5" (4 yrs.)	8" (12 yrs.)	10" (>12 yrs.)

The above settlement estimates are from consolidation of the subsoils below the base of terraces and do not consider the settlement within the earthen terraces. This settlement is difficult to estimate since it depends on the degree of compaction of the material that is used to construct the terraces. It is believed that the settlement within the terraces could be as high as several inches. This will be additive to the consolidation settlement of the subsoils given above. It is believed that about

50 percent of estimated settlement will occur shortly after construction and the remaining settlement will occur over several years.

Slope Stability Analyses

The crown elevation of the terraces was assumed to range from EL.+3.0 to EL.+5.0 and toe elevation of terraces at EL.-1.0. Considering that the dredged material near the proposed terraces will be used for construction of terraces, it is recommended that the dredge area be at least 20 feet from toe of the terraces and the dredge canal should match the slope of the terraces. In order to improve the stability of earthen terraces, it was assumed that a layer of geotextile fabric reinforcement will be placed at the base of the proposed earthen terraces. The height, side slope and other related information considered in the analyses are summarized below.

Terrace Crown Elevation (Feet)	Terrace Toe Elevation (Feet)	Terrace Side Slope	Crown Width (Feet)	Dredged Canal Slope	Dredged Canal Bottom Elevation (Feet)
+3.0	-1.0	1V:4H	10	1V:4H	-5.0
+4.0	-1.0	1V:4H	10	1V:4H	-6.0
+5.0	-1.0	1V:5H	10	1V:5H	-7.0

The upper 12 feet of the subsoils encountered in the borings consist of very soft clays. It is believed that most of this material will be suitable for construction of the proposed earthen terraces. The in-situ clays should be placed in horizontal lifts not exceeding one (1) foot and should be mechanically compacted to achieve some degree of compaction.

In view of the above, slope stability analyses were performed based on "Bishop Method" with modifications to account for the stabilizing influence of the horizontal reinforcement layer to determine stability of the proposed terraces and the results are given below and in Appendix II. The low water was assumed to be at EL.+0.8 in the area of the proposed terraces.

Terrace Crown Elevation (Feet)	Terrace Toe Elevation (Feet)	Terrace Side Slope	Factor of Safety Without Reinforcement	Factor of Safety with Reinforcement
+3.0	-1.0	1V:4H	1.50	2.20 (HS 400)

+4.0	-1.0	1V:4H	1.25	1.77 (HS 400)
+5.0	-1.0	1V:5H	1.10	1.65 (HS 600)

It is recommended that a geotextile fabric (Mirafi Geolon HS400 or HS600) or equivalent be placed at the base of the proposed terraces to increase stability and bearing capacity. This should be installed per manufacturer's specifications and properly anchored at the base of the terraces. The Mirafi Geolon HS400 and HS600 technical sheets are included in Appendix II. As indicated previously, the above minimum factors of safety are believed to be adequate for the proposed terrace construction. It is important to note that this is based on the dredged canal being at least 20 feet from the toe of the proposed terraces.

Staged Construction

Considering the limited bearing capacity of subsoils and the anticipated settlements as discussed above, it is recommended to construct the terraces in two stages to allow for some consolidation of the subsoils to occur. This will strengthen the subsoils and improve the bearing capacity and stability for final stage of construction. It is recommended that for the first stage of construction, all terraces be constructed to about EL.+2.0. After the last terrace is constructed to EL.+2.0, the final stage of construction can begin for the first constructed earthen terrace. This will allow for some gain in strength of the subsoils due to consolidation between the two stages of construction.

REPORT LIMITATIONS

The recommendations submitted in this report are preliminary and based on the available subsurface information obtained by PSI and design details furnished by Hartman Engineering, Inc. Before final design and preparation of plans and specifications, PSI should be retained to perform a detailed design level geotechnical report. If PSI is not notified of such changes, PSI will not be responsible for the impact of those changes on the project.

The geotechnical engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

After the plans and specifications are more complete, the geotechnical engineer should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents. At that time, it may be necessary to submit supplementary recommendations. If PSI is not retained to perform these functions, PSI will not be responsible for the impact of those conditions on the project. This report has been prepared for the exclusive use of LDNR and Hartman Engineering,

Inc. for the specific application to the proposed Earthen Terraces in Vermillion Parish, Louisiana.

APPENDIX II

LOG OF BORING B-1

FRESHWATER INTRODUCTION-SOUTH OF HIGHWAY 82, ME-16
VERMILLION PARISH, LOUISIANA
N29° 39' 41" (LAT) - W92° 37' 04" (LON)

TYPE OF BORING: WET ROTARY | LOCATION: SEE APPENDIX | PSI PROJECT NO.: 254-35162

DEPTH, FT.	SOIL TYPE	SAMPLES	DESCRIPTION	N-BLOWS/FT.	UNCONFINED COMPRESSIVE STRENGTH tsf	HAND PENTROMETER tsf	TORVANE tsf	UNIT DRY WEIGHT pcf	MOISTURE CONTENT %	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200 SIEVE
			MUDLINE									
			Very soft gray Clay		0.07		0.10	43	106			
					0.03	(2.4)	0.05	41	115	130	109	
5					0.03		0.05	39	121			
							0.05		108	135	116	
					0.08		0.05	63	65			
10												
			Stiff greenish gray and reddish tan Clay			1.25			24	66	51	
15												
					1.47	1.50		98	26			
20												
						1.50			29	72	54	
25												
			Value in ( ) indicate % organic content									
30												
35												
40												
45												
50												

DEPTH OF BORING: 25 Feet | WATER DEPTH TO MUDLINE: 3 Feet

DATE: March 2, 2004

psi *Geotechnical Consulting Services*
Jefferson, Louisiana

LOG OF BORING B-2

FRESHWATER INTRODUCTION-SOUTH OF HIGHWAY 82, ME-16
VERMILLION PARISH, LOUISIANA
N29° 39' 12" (LAT) - W92° 36' 58" (LON)

TYPE OF BORING: WET ROTARY | LOCATION: SEE APPENDIX | PSI PROJECT NO.: 254-35162

DEPTH, FT.	SOIL TYPE	SAMPLES	DESCRIPTION	N-BLOWS/FT.	UNCONFINED COMPRESSIVE STRENGTH tsf	HAND PENTROMETER tsf	TORVANE tsf	UNIT DRY WEIGHT pcf	MOISTURE CONTENT %	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200 SIEVE
			Very soft gray Clay		0.05		0.05	39	125			
					0.05		0.05	38	126	130	105	
5						(2.5)	0.05		132			
							0.05		120	127	98	
10							0.05		120			
			Soft to firm gray Sandy Clay		0.29		0.15	93	29			57
15												
							0.15		26	33	14	70
20												
					0.57	0.75		89	34	62	44	
25												
			Value in ( ) indicate % organic content									
30												
35												
40												
45												
50												

DEPTH OF BORING: 25 Feet | WATER DEPTH TO MUDLINE: 4 Feet

DATE: March 2, 2004

LOG OF BORING B-3

FRESHWATER INTRODUCTION-SOUTH OF HIGHWAY 82, ME-16
VERMILLION PARISH, LOUISIANA
N29° 39' 30" (LAT) - W92° 36' 12" (LON)

TYPE OF BORING: WET ROTARY | LOCATION: SEE APPENDIX | PSI PROJECT NO.: 254-35162

DEPTH, FT.	SOIL TYPE	SAMPLES	DESCRIPTION	N-BLOWS/FT.	UNCONFINED COMPRESSIVE STRENGTH tsf	HAND PENTROMETER tsf	TORVANE tsf	UNIT DRY WEIGHT pcf	MOISTURE CONTENT %	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200 SIEVE
			Very soft gray Clay		0.03		0.05	44	108	127	98	
							0.05		117			
5					0.08		0.05	43	118	131	101	
							0.05		126			
10					0.03		0.05	59	79			
			Stiff greenish gray and reddish tan Clay			2.00			24			
15												
20					1.63	1.75		104	23	43	29	
25						2.00			39			
30												
35												
40												
45												
50												

DEPTH OF BORING: 25 Feet | WATER DEPTH TO MUDLINE: 3 Feet

DATE: March 2, 2004

LOG OF BORING B-4

FRESHWATER INTRODUCTION-SOUTH OF HIGHWAY 82, ME-16
VERMILLION PARISH, LOUISIANA
N29° 39' 05" (LAT) - W92° 36' 36" (LON)

TYPE OF BORING: WET ROTARY | LOCATION: SEE APPENDIX | PSI PROJECT NO.: 254-35162

DEPTH, FT.	SOIL TYPE	SAMPLES	DESCRIPTION	N-BLOWS/FT.	UNCONFINED COMPRESSIVE STRENGTH tsf	HAND PENTROMETER tsf	TORVANE tsf	UNIT DRY WEIGHT pcf	MOISTURE CONTENT %	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200 SIEVE
			Very soft gray Clay				0.10		109			
					0.02		0.05	39	129	135	104	
5					0.03		0.05	45	110			
							0.05		111			
							0.05		114	126	98	
10												
			Stiff greenish gray and tan Clay		1.19	1.75		100	27	70	51	
15												
						2.00			27			
20												
						2.00			25			
25												
30												
35												
40												
45												
50												

DEPTH OF BORING: 25 Feet | WATER DEPTH TO MUDLINE: 2 Feet

DATE: March 2, 2004

APPENDIX III